Boston Harbor Project
Sludge Digesters

The Massachusetts Water Resources Authority is building one of the largest installations of egg-shaped sludge digesters in the world as part of the Boston Harbor Project. The 16 digesters will process sludge (solids) from a new primary and secondary treatment plant at Deer Island.

Wastewater treatment

The new sewage treatment plant on Deer Island will treat the wastewater from homes, businesses and institutions in the 43 metropolitan Boston communities that receive sewer services from the MWRA. The new plant will have a peak capacity of 1.3 billion gallons a day (bgd).

The digesters will use a biological process called "anaerobic digestion" to cut the volume of sludge (fecal matter and other solids removed from wastewater during the treatment process) and to reduce disease and odor-causing bacteria.

Digested sludge will then be conveyed six miles south across the harbor, by barge, to a sludge processing plant in Quincy. There, the sludge will be dewatered, heat-dried, converted into pellets and marketed for use as a fertilizer.

Sludge is produced in both the primary and secondary treatment processes. Primary treat-ment relies on physical methods to remove solids from wastewater: heavy solids fall to the bottom of settling tanks, called clarifiers, and then are pumped to the digesters.

Secondary treatment is a biological process that removes most of the biological oxygen demand (BOD) and remaining solids in wastewater. Secondary treatment combines wastewater and microorganisms in large tanks with constant aeration (oxygen input) and mixing. The material that remains at the end of this process, called secondary sludge, is also pumped to the sludge digesters.

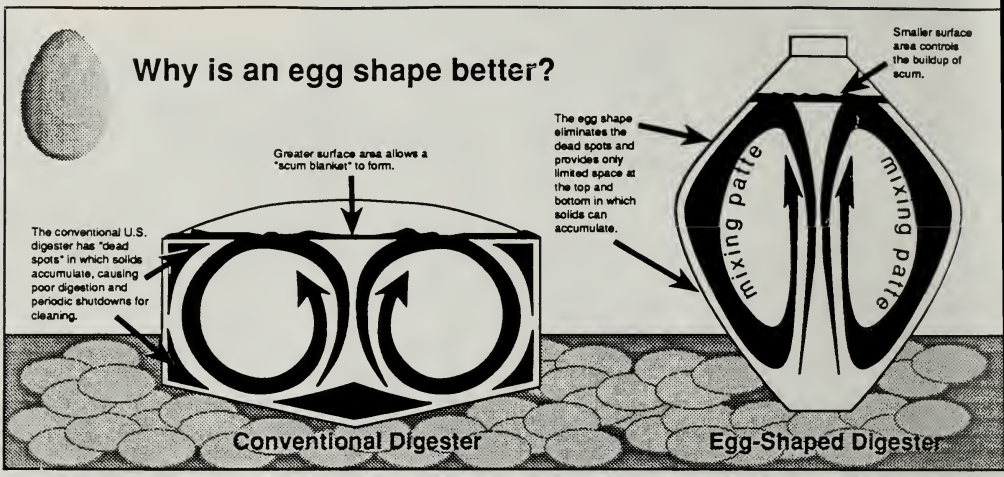
Role of sludge digesters

Digesters process liquid sludge for 10 to 22 days. The natural decomposition process that takes place in these large, air-free tanks cuts the volume of sludge by as much as 45 percent and substantially reduces disease- and odor-causing bacteria. The sludge is heated to 95 degrees Fahrenheit and kept in constant circulation. The airless environment breaks down the sludge, creating methane gas that is subsequently used to fuel the power plant. Sludge from the digesters is transported by barge to the Fore River pelletizing facility for dewatering and heat drying.

Looking at the eggs

One of the most striking things about egg-shaped digesters is their appearance. This factor led the Authority's design team to assess the visual impact of the digesters on residents of the adjacent town of Winthrop and on harbor users.

To evaluate the impact of the "eggs" on Winthrop residents, the engineers relied on computer-generated drawings of Deer Island showing the digesters from various vantage points in the town. The results show that the landform being created on the island's northeast side will obscure all but a small corner of the digesters. The 120-foot high landscaped hill will block the eggs from the view of most Winthrop residents.



Where are the eggs?

Egg-shaped digesters have long been used in Europe and in Japan. There are more than 100 installations of egg-shaped digesters in Germany, where they were first designed and used in the 1960s. The eggs have been well-suited to nations where population density and the lack of large amounts of open space make it difficult to use the conventional tanks. The eggs' energy efficiency and low maintenance requirements also contributed to their popularity in Europe and Japan.

Four 1.4-million-gallon egg-shaped digesters were part of the Terminal Island sewage treatment plant in Los Angeles in the late 1970s, and two 3-million-gallon eggs are now being built as part of Baltimore's Back River wastewater treatment plant. Sixteen 2.5-million-gallon digesters are planned for the Hyperion treatment plant in Los Angeles.

A $16 million project to build four of the world's largest egg-shaped digesters is now nearing completion in Bottrop, Germany. Each digester will be nearly 150 feet high and have a capacity of 4 million gallons. The digesters are part of the Emschermundung wastewater treatment plant located in an industrial area that serves nearly five million people.

The egg versus the tank

The existing Deer Island digesters are of the conventional design for American treatment plants: a cylindrical tank with a flat or gently sloping bottom. The new egg-shaped digesters, in use in Germany, Japan and a few U.S. cities, require less maintenance, are more energy efficient and take up less space than the conventional design. Each egg-shaped digester stands 110 feet above ground (as high as a five-story building), with a 90-foot diameter and a capacity of three million gallons.

Because they are tall and narrow, egg-shaped digesters require significantly less land than conventional tanks, allowing for the construction of the 16 digesters planned for Deer Island on just five acres of land. Conventional tanks would take twice the space of the egg-shaped digesters.

Problems with operating and maintaining the current digesters also influenced the decision to use egg-shaped digesters. Nearly two-thirds of the MWRA's sewer system operates with combined sewers, bringing high levels of grit (sand and dirt) through the treatment plant. As digesters fill with

settled grit, their capacity is reduced and the system that mixes and circulates the sludge is damaged.

Other operations problems at the existing plant resulted from solids accumulating in the bottom of the digesters and the formation of a "scum blanket" on top. This layer of scum has fouled the digesters' internal mixing guns, causing poor digestion and periodic shutdowns for cleaning.

Digester cleaning is a messy, odorous and expensive process that temporarily removes the tank from service. Constructing permanent cleanout facilities would require additional land space on Deer Island. In addition, the MWRA wants to avoid any odor problems inherent in cleaning conventional digesters.

Because they are self-cleaning, egg-shaped digesters do not have many of the problems common to conventional digesters. The geometry eliminates the "dead spots" where solids build up in conventional tanks. The smaller surface at the top of the egg discourages the buildup of scum. The tapered shape of the bottom of the digester and the fact that the sludge is withdrawn from the base stop grit from accumulating in that area.

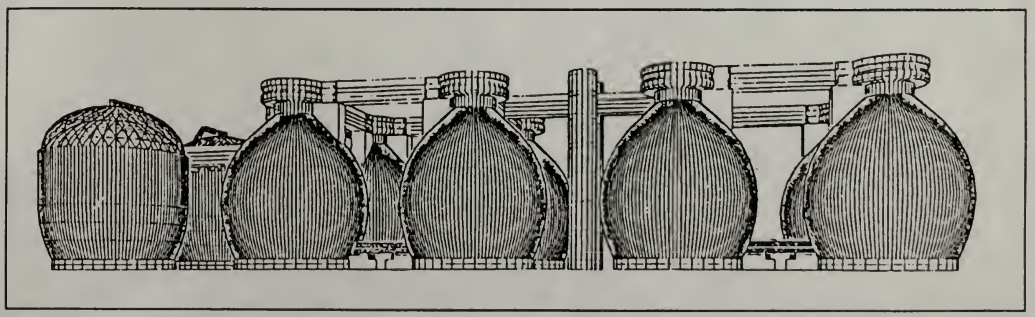
Building the eggs

Egg-shaped digesters are as much as 30 percent more expensive to construct than conventional tanks, but are less expensive to operate and maintain. Construction costs will be offset by savings in energy costs estimated at nearly $400,000 a year.

The digesters on Deer Island will be built of welded steel, insulated and covered with an aluminum jacket. As part of the digester complex, six concrete gravity thickener tanks 24 feet high with a diameter of 70 feet will be built. The digester complex also includes two storage tanks that will be 110 feet high by 90 feet wide. Digested sludge will be stored in those tanks until it is ready to be transferred to a barge that will take it to the Authority's sludge processing plant at the Fore River Staging Area in Quincy. At the Quincy plant, digested sludge will be converted to a pellet fertilizer. The digester project also includes the construction of a four-story concrete support building for the sludge thickener complex, and a five-story concrete support building for the digesters. These structures house pumps, controls and odor control facilities.

Construction of the first eight digesters began in the fall of 1991. The joint venture of the Perini Corp. and Eastern Contractors, Inc., both of Framingham, was awarded a $189 million contract to construct the digesters. The first eight digesters will process sludge from the new primary treatment plant at Deer Island.

Four additional digesters will be constructed and put in service by the middle of 1996 to coincide with the partial startup of the secondary treatment plant. The remaining four digesters will be needed by late 1999 when the secondary treatment plant is completed.



Computer rendering of digesters and sludge storage tanks (at left) on Deer Island.